WE CLAIM:

Sub B1

1. A method for producing a boride layer on a surface by plasma boronizing comprising:

supplying a gas mixture containing a boron-releasing gas to a treatment chamber of a reactor;

generating a glow discharge in the reactor;

determining the amount of at least one excited boron-releasing gas product in the glow discharge; and

selecting production parameters of the plasma generated in the treatment chamber of the reactor so that a minimum and/or maximum value of the determined excited boron-releasing gas product and/or a minimum or maximum value of a relation of one or more of the determined excited boron-releasing gas products to another glow discharge product are maintained.

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2. A method for producing a boride layer on a surface by plasma boronizing comprising:

supplying a gas mixture containing a boron-releasing gas to a reactor; and generating glow discharge in the reactor using a pulsed DC voltage source having a ratio of voltage pulse duration to subsequent pulse pause duration which is greater than 1.1:1.

3. A method for producing a boride layer on a surface by plasma boronizing comprising:

supplying a gas mixture containing a boron-releasing gas to a reactor; and

generating a glow discharge in the reactor by applying a DC voltage in pulses having a pulse period of less than 230 μs.

4. A method for producing a boride layer on a surface by plasma boronizing comprising:

supplying a gas mixture containing a boron-releasing gas to reactor; and

generating a glow discharge in the reactor while maintaining the gas mixture at a selected low treatment temperature during a first stage to first produce a relatively thin, dense boride layer and prevent formation of halogenides which cause formation of pores, and maintaining the gas mixture at a higher temperature during in a second stage.

5. A method according to claim 1 wherein the glow discharge is produced using a pulsed DC voltage source having a ratio of voltage pulse duration to subsequent pulse pause duration which is greater than 1.1:1.

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6. A method according to claim 1 wherein the glow discharge is generated by applying DC voltage pulses having a pulse period of less than 230 μs.

7. A method according to claim 1 wherein the method includes a first stage during which the gas mixture is maintained at a selected low temperature to prevent formation of halogenides which cause formation of pores to first produce a relatively thin, dense boride layer, followed by a second stage during which the gas mixture is maintained at a higher temperature.

8. A method according to claim 2 wherein the glow discharge is generated by applying a DC voltage in pulses having a pulse period of less than 230 μs.

9. A method according to claim 2 wherein the method includes a first stage during which the gas mixture is maintained at a selected low temperature to prevent formation of halogenides which cause formation of pores to first produce a relatively thin, dense boride layer, followed by a second stage during which the gas mixture is maintained at a higher temperature.

10. A method according to claim 3 wherein the method includes a first stage during which the gas mixture is maintained at a selected low temperature to prevent formation of halogenides which cause formation of pores to first produce a relatively thin, dense boride layer followed by a second stage during which the gas mixture is maintained at a higher temperature.

11. A method according to claim 2 or claim 5 including determining the amount of excited boron-releasing gas in the reactor at least in a relative manner.

12. A method according to claim 11 including determining spectroscopically the amount of excited boron-releasing gas in the reactor.

13. A method according to claim 11 including determining the amount of excited boron in the reactor at least as a function of the amount of excited boron-releasing gas in the reactor.

14. A method according to claim 13 wherein, in order to form a minimum or maximum value of the excited boron-releasing gas content, the determined amount of the excited boron-releasing gas is set in relation to a determined amount of at least one further boron-releasing gas product.

15. A method according to any one of claims 1-4 wherein a gas mixture is supplied which contains a boron trihalide as a boron-releasing gas in a concentration greater than about 1% by volume, along with hydrogen gas and, optionally, a noble gas.

16. A method according to any one of claims 1-4 wherein the glow discharge is generated by applying a pulsed DC voltage which has a ratio of the voltage pulse duration to the subsequent pulse pause duration in the range from about 1.1:1 to 5:1.

17. A method according to claim 16 wherein the ratio is in the range from about 1.5:1 to 3.5:1.

18. A method according to any one of claims 1-4 wherein a pulsed DC voltage having a pulse period of less than about 210 μs is used for generating the glow discharge.

19. A method according to claim 18 wherein the pulsed DC voltage has a pulse period $\geq$ 50 μs.

20. A method according to claim 19 wherein the voltage of the pulsed DC voltage used for generating the glow discharge in the range between about 500 volts and about 1000 volts.

21. A method according to claim 20 wherein the voltage is in the range between about 650 volts and about 800 volts.

22. A method according to any one of claims 1-4 wherein the reactor pressure is maintained in a low-pressure range between about 0.5 and about 15 hPa.

23. A method according to claim 22 wherein the reactor pressure is maintained in the range between about 1 and about 10 hPa.

24. A method according to any one of claims 1-4 wherein the gas mixture contains a boron trihalide in a concentration of between 2% by volume and about 50% by volume.

25. A method according to claim 24 wherein the boron trihalide concentration is between about 2% by volume and about 10% by volume.

26. A method according to any one of claims 1-4 wherein the gas mixture contains up to 20% by volume of a noble gas and 2% by volume to 50% by volume of boron trihalide, the remainder being hydrogen gas.

sub B3 > 27. A method according to claim 26 wherein the noble gas is argon.

28. A method according to claim 26 wherein the gas mixture contains 2% by volume to 20% by volume of boron trihalide.

29. A method according to any one of claims 1-4 wherein the boron-releasing gas is one of BCl_3, BF_3 and mixtures thereof.

30. An arrangement for producing a boride layer on a surface by plasma boronizing comprising:

a reactor having a treatment chamber;

a glow discharge generator in the reactor chamber;

a gas supply device through which a gas mixture containing a boron-releasing gas is supplied to the reactor; and

a pulsed DC voltage source for applying pulsed DC voltage with a controllable pulse width and/or pulse pause.

31. An arrangement according to claim 30 including at least one mass flow meter for measuring and/or controlling the composition and/or the flow rate of at least one of the gases in the gas mixture.

32. An arrangement according to claim 31 including at least two flow meters for measuring and/or controlling the flow rate of the boron-releasing gas and/or hydrogen gas and/or a noble gas.

33. An arrangement to claim 30 including a pressure gauge for measuring the pressure in the reactor.

34. An arrangement according to claim 33 including a computer for controlling the measurement of pressure in the treatment chamber by the pressure gauge.

35. An arrangement according to claim 30 including a gas spraying device for ~~distributing the gas mixture into the reactor treatment chamber.~~

36. An arrangement according to claim 30 including a cooled gas inlet for the boron-releasing gas.

37. An arrangement according to claim 30 including a gas purification device connected to the treatment chamber for waste gas treatment.

38. An arrangement according to claim 37 including a vacuum pump connected to the gas purification device.

39. An arrangement according to claim 30 including heating means in the reactor for achieving a desired treatment temperature.

ADD B_4 >